THE

Indian Tea Association.

SCIENTIFIC DEPARTMENT

QUARTERLY JOURNAL.

PART IV.

1925.

Calcutta:
PRINTED AT THE CATHOLIC ORPHAN PRESS,
3 & 4, Portuguese Church Street.

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THE EFFECT ON TEA CROP OF A LEGUMINOUS CROP WHILE GROWING

BY

H. R. COOPER.

It has often been pointed out in publications by this Department that while a green crop is growing among tea, the tea suffers to a greater or less extent. This is only a particular case of the general rule that any plant growing in the neighbourhood of another exercises a depressant effect on its rate of growth.

Leguminous plants are however peculiar in that they are, to a large extent, able to provide their own nitrogen instead of depleting the soil of this important constituent. Many statements have been made by other authorities to the effect not only that leguminous plants do not harm their neighbours but also that they actually, while growing, benefit them.

This is an important question about which there should be no doubt and it would be interesting also to have a rough idea of the actual loss in tea crop suffered from a particular growth of green crop.

In 1925, at Borbhetta, the Lime Experiment Plots received as their treatment under the scheme laid down, a rahar (*Cajanus indicus*) crop to be trenched in at the end of the year. The lime was applied in 1922, and up to the end of 1924 (as reported in Quarterly Journal, 1925, part 1, p. 1) the effect on the tea was a very small depression in crop. On the rahar crop (as on the cow-peas in 1923), the lime exercised a very great good effect, and the greater the quantity of lime used the better was the rahar crop.

With the actual effect of the lime on the tea, this article is not concerned; but the effect of using dressings of lime varying between *nil* and 80 maunds per acre was to produce rahar crops varying between *nil* and 250 maunds of plant per acre. These plots therefore have provided cases where the effects on the tea of varying growths of rahar may be observed.

The experiments are on a block of tea divided, like a chess board, into 64 plots each containing 80 bushes planted 5 by 5 triangular, the area of each plot being thus $\frac{1}{25}$ acre. For the sake of ease of comparison the yields per plot have been, in the following tables, calculated into maunds of made tea per acre assuming that 4 lbs. of green leaf make 1 lb. of tea.

1		2	3		4	5
Plot.		Arhar Crop in mds. (green stuff per acre).	Tea Crop in mds. (pucca tea per acre).		Loss% in tea crop in 1925 compared to 1924.	Remarks.
Serial Number.	Plot Mark.		1924.	1925.		
1	162 e	*Nil.*	10·22	10·84	6 (gain)	Mean 2% gain — No lime or other manure at any time.
2	160 h	,,	11·39	11·86	4 (gain)	
3	156 a	,,	16·15	16·38	1 (gain)	
4	157 f	,,	14·74	14·82	0	
5	159 e	,,	11·47	11·47	0	
6	161 a	,,	12·40	12·32	1	Mean 3½% loss Probable error of mean =±1. — 15 mds. per acre limestone 1922 but no other manure at any time.
7	162 f	,,	11·08	11·00	1	
8	156 b	,,	14·90	14·76	3½	
9	157 g	,,	12·48	11·93	4½	
10	159 d	,,	8·27	7·57	8½	
		Crop under 25 mds.				
11	156 c	7·5	17·08	17·16	0	
12	162 g	9·5	13·96	14·36	3 (gain)	
13	157 h	12·7	12·01	11·54	4	Mean 1% loss. Probable error of mean =±1.
14	161 b	19·8	12·09	12·09	0	
15	156 d	23·6	15·21	15·13	½	
16	158 a	24·1	17·24	16·54	4	
		Crops from 25 to 50 mds.				
17	163 a	41·8	11·62	10·17	11	
18	158 c	43·1	15·05	12·95	14	
19	162 h	44·0	13·03	12·56	4	Mean 6% loss. Probable error of mean =±3.
20	156 e	48·1	14·27	15·68	10 (gain)	
21	157 a	50	17·79	15·60	13	
		Crops from 50 to 75 mds.				
22	157 b	55·0	16·45	15.52	12	
23	160 a	56·0	14·84	11·08	25	
24	158 b	57·6	17 08	15·05	12	
25	157 c	61·0	15·60	14·98	4	Mean 11% loss. Probable error of mean =±2.
26	159 e	61·7	10·37	10·37	0	
27	162 d	69·5	10·22	8·89	13	
28	163 b	70·4	9·44	8·82	6½	
29	162 a	70·9	11·00	8·35	24	
30	161 g	72·9	14·27	82·71	11	
31	156 f	73·5	15·37	14·37	6½	

1		2	3		4	5
Plot.		Arhar Crop in mds. (green stuff per acre.)	Tea Crop in mds. (pucca tea per acre).		Loss% in tea crop in 1925 compared to 1924.	Remarks.
Serial Number.	Plot Mark.		1924.	1925.		
		Crops from 50 to 100 mds.				
32	161 d	76·4	9·54	8·42	13	
33	158 d	77·5	7·41	6·63	10	
34	163 d	78·1	12·25	11·31	8	Mean 10% loss.
35	158 e	85·4	8·81	7·41	16	Probable error of mean
36	161 c	79·4	8·81	8·66	2	$=\pm 1$.
37	158 g	89·2	13·87	13·65	2	
38	157 d	90·9	11·31	9·98	12	
39	160 b	92·2	12·64	10·76	14	
40	158 f	96·6	12·32	11·70	5	
41	161 h	99·2	12·87	10·45	19	
		Crops 100 to 125 mds.				
42	156 h	101·4	13·65	11·70	14	
43	160 c	105·9	12·32	10·69	13	
44	160 d	106·5	11·94	9·67	20	
45	163 h	106·6	11·23	8·58	24	
46	160 f	109·3	13·42	11·94	11	Mean 16% loss.
47	156 g	110·4	14·12	12·09	14	Probable error of mean
48	157 e	111·9	13·65	11 70	15	$=\pm 1$.
49	163 c	116·4	10·76	8·81	18	
50	163 f	117·2	11·05	8·97	19	
51	161 e	119·5	12·32	10·14	17	
52	159 h	121·4	13·26	12·09	9	
53	159 g	122·2	14·20	12·17	14	
54	160 c	123·3	10·84	9·13	16	
		Crops 125 to 150 mds.				
55	162 b	130·4	11·62	9·05	22	
56	163 e	132·5	10·30	8·74	15	
57	162 c	135·5	11·39	8·97	21	Mean 19% loss.
58	158 h	136·7	13·65	11·70	14	Probable error of mean
59	159 a	137·2	17·24	11·86	31	$=\pm 2$.
60	159 f	137·3	13·34	11·70	12	
61	163 g	137·6	10·53	8·35	21	
		Crops over 150 mds.				
62	161 f	162·1	14·12	11·86	16	
63	160 g	201·8	12·79	8·42	34	
64	159 b	248·4	13·96	8·74	37	

The figures for loss of tea crop do not vary at all strictly with the weight of arhar cut. This indeed would hardly be expected, for the actions of tea plant, arhar plant, and soil on each other are very complicated. Lime certainly encourages the growth of arhar greatly, while slightly discouraging the growth of tea. Plots receiving the larger dressings of lime therefore show generally the largest crops of arhar and the greatest loss of crop of tea. Soils however are good or bad both for arhar and for tea in other respects than their lime content.

In general, plots which have grown fair crops of arhar without much lime show a smaller depression of tea crop than plots, carrying the same crop of arhar, which have received sufficient lime to favour the arhar at the expense of the tea. Also, plots already very fully occupied by strongly growing tea allow less growth of arhar, but in such cases the tea may suffer greatly from a relatively small crop of arhar. Thus, with all these complications the depression of tea crop does not depend only on the weight of the arhar crop. Still, from the 64 plots we have enough evidence to show that the tea has suffered from the growth of arhar amongst it, and that, other things being equal, the greater the arhar crop the greater is the loss of tea crop.

Roughly the loss of tea crop is :—

Weight of arhar mds. per acre.		Loss of tea crop per cent.
under 25 mds.	...	Negligible
25 to 50 ,,	...	5 per cent.
50 to 100 ,,	...	10 ,, ,,
100 to 125 ,,	...	15 ,, ,,
125 to 150 ,,	...	18 ,, ,,
200 to 250 ,,	...	35 ,, ,, (two plots only)

That is, in this case, the depression in tea crop is roughly 13 per cent. for every 100 maunds of arhar per acre.

Such a loss is big enough to make it well worth to take measures to reduce it.

Losses occur, not only with crops like arhar which occupy the soil the whole year, but also with quick growing crops like

mati kalai, dhaincha, cowpeas or sunn hemp. In "Green "Manuring in Tea Culture in India,"* Mann and Hutchinson proved this point completely in the case of mati kalai, crotalaria striata, dhaincha, and ground nuts. In each case there was a gain in tea crop by the end of the season ; but the tea commenced to gain on the check plot only some time after the green crop was hoed in, while the tea crop suffered during the period of growth of the green crop. One case only needs to be quoted here as an example. In this case the mati kalai was sown on 5th May and hoed in on 5th July. During this period it will be seen that the tea definitely lost, and that no definite increase in tea crop was observed till the plucking of 1st August, about four weeks after the mati kalai had been hoed in. The weight of mati kalai is not recorded, but it is noted that it was not a good crop.

Date.		Mati kalai.	No Mati kalai.	Difference.	
				Loss.	Gain.
		lbs.	lbs.		
June	5	31·6	52·5	29·9	...
,,	12	23·1	23·8	0·7	...
,,	19	14·6	28·1	13·5	...
,,	27	31·6	30·6	...	1·0
July	4	32·2	40·3	8·1	...
,,	11	33·3	32·0	...	1·3
,,	18	38·9	42·7	3·8	...
,,	25	39·5	41·6	2·1	...
August	1	55·3	44·7	...	10·6
,,	8	54·1	38·8	...	15·3
,,	15	44·0	30·1	...	13·9
,,	22	40·0	44·7	4·7	...
,,	29	49·6	34·0	...	15·6
September	5	42·8	37·9	...	4·9
,,	12	41·7	45·6	3·9	...
,,	19	36.1	21·3	...	14·8
,,	26	30·4	42·2	11·8	...
October	3	49·6	33·0	...	16·6
,,	10	32·7	33·0	0·3	...
,,	17	35·0	28·1	...	6·9
,,	24	37·2	39·8	2·6	...
November	2	40·6	33·0	...	6·4
,,	11	46·2	23·5	...	12·7
,,	21	30·4	24·3	...	6·1

Cases are also recorded where tea crop was lost over the whole season when green crops were grown.

* Indian Tea Association, 1906, No. 2.

The suffering of the tea while a green crop is growing is then an established fact. This does not mean that green crops must not be grown, for the gain normally outweighs the loss, but it means that precautions should be taken to reduce this loss to a minimum. In order to do this we must consider to what causes the loss is due. These causes are :—

(1) Competition of the green crop with the tea for (*a*) actual root-room, for (*b*) food and for (*c*) water.

(2) Depression of rate of formation of nitrates in the soil on account of the presence of extra roots in the soil.

(3) In some cases, over-heavy shade.

(1) The competition for root-room can be reduced by allowing the green crop to occupy soil for the minimum time, and in the case of the semi-permanent crops like arhar by lopping the plant so that it does not become too big. Competition for food can also be reduced by making certain that there is enough food for both. Competition for water is the most serious of all the causes for loss of tea crop. Reduction of tea crop over a whole season from the use of a quick-growing green crop has only been observed in droughty years. Loss from this cause must be avoided by waiting till the rain starts before sowing either a quick-growing, or a semi-permanent green crop ; while should a seriously dry period set in after the plants have grown, the green crop should be hoed in.

(2) and (3). These causes of loss can be reduced in the case of the quick-growing crop by allowing it to occupy the soil for minimum time, and in the case of the semi-permanent crop by lopping it.

Our recommendations then, are :—

Semi-permanent crops like arhar—

(1) Sow as late as possible, and trench or deep-hoe in before the weather is very dry.

In high and wide-spreading tea it will be necessary to sow fairly early, say late in March, before

the tea is leafy, or the green crop will not grow. In young or cut down tea, arhar will make ample growth if not sown till June.

By burying the crop early, much suffering by drying of the soil is avoided.

(2) Do not grow the plants too thickly.

For sowing in alternate rows, 2 seers of seed per acre is ample. Usually, to allow for uneven germination 5 seers is sown. In either case the crop will be too thick at least in some places. When the young plants are about six inches high, they should be thinned out with a hoe, leaving about 1 plant per foot.

(3) Lop the plants frequently, so that the tea is not smothered. Tea gains from light shade overhead, but suffers from over-heavy shade, particularly from shade close to its surface. In arhar or Boga medeloa an umbrella shape should be attained, by cutting away the sides leaving only the growth on top. Four to six loppings are necessary. The tea then gains from the manurial effect of the loppings, even during the growth of the green crop. It is convenient and effective to lop just before a light hoe.

(4) Manure the tea, whenever a semi-permanent green crop is grown. For all soils, except very sandy ones, the mixture mentioned below is excellent. It should be forked in around the bushes, as its object is not to encourage the green crop, but to enable the tea to withstand its competition. At the same time the green crop should be encouraged by a dressing of phosphatic manure, and if necessary, lime, along the lines where the crop will be sown. This not only encourages the growth of root-nodules, enabling the green crop to obtain its own nitrogen from the air, but will hasten the time

of decomposition of the buried green crop, during which time also the tea suffers.

Cheap and efficient dressings for these purposes on most soils are :—

For the tea—

2 mds. sulphate of ammonia
½ md. sulphate of potash
per acre.

cost in Calcutta about Rs. 16-4 per acre.

For the green crop—

2 cwt. Belgian Flour Phosphate per acre, cost in Calcutta Rs. 5-8.

or if lime is not greatly required—

1¼ cwt. ground Indian Phosphate per acre, cost in Calcutta Rs. 4-11.

(5) If possible, bury the crop not later than December.

Quick growing green crops like cowpeas.

1. Choose a crop which suits the conditions.

On most soils cowpeas give the biggest crop in the shortest time and for that reason the cowpea is generally the best crop to use.

On some soils, mati kalai will do better, particularly if it has to struggle against jungle.

Both these, and particularly mati kalai, are of creeping habit, and give trouble by getting amongst the bushes. Also, both these grow relatively poorly under high and wide-spreading tea, in which case an erect plant is to be preferred.

On many soils, particularly good light soils, sunn hemp does as well as cowpea, and has the further advantage of containing a higher percentage of nitrogen.

Dhaincha often does well, but is very variable. The seed obtainable is not always good. This plant however is very valuable in unfenced areas, since cattle do little damage to it. They may eat it if they can get nothing else, but never like it.

Many other plants have been tried but no others are consistently satisfactory as quick-growing crops in the plains. Soybeans (Bhotmas) do well in the hills.

2. Sow as soon as rain starts.

Not before or the crop will grow poorly, while the more growth it does make the worse for the tea.

Not too late or the green crop will not grow well under leafy tea, while the loss of tea crop will be greater if the green crop is present at the time when the tea should be yielding heavily. A green crop is in any case a nuisance to pluckers during the height of the plucking season.

Normally sowings should be distributed from mid-March to the end of April. Green crops are then all out of the way by mid-June. If the rain starts late, so will the tea, and green crops may be correspondingly late also.

3. Allow the crop to occupy the soil for the shortest possible time.

At the same time we want a big weight of green stuff to manure the tea, so that our problem is to get rapid growth of green crop.

We get this, first by sowing the green crop on thoroughly clean soil pulverised to make a good seed bed. This seed bed need only be a foot wide, and on heavy soils it is well to make it slightly raised.

Secondly, we can manure the green crop. For this purpose, phosphates should nearly always be applied. It is advised that most of the phosphatic manure considered necessary for the tea in the course of the rotation, should be applied with the green crop. On some soils nitrogen also may be necessary, but on average soils no nitrogenous manure should be given, since the object of using a leguminous crop is that its nitrogen shall be extracted from the air and thus enrich the soil with nitrogen obtained without cost. The main object of green manuring, however, is to maintain the soil's organic matter content, and

on soils known to grow green crops poorly a light dressing of nitrogen should also be given.

For quick-growing crops therefore the following manuring is advised.

Practically always a manure to supply 40 to 120 lbs. phosphoric acid per acre. The smaller dressing will be on sands, and the larger on heavy soils on which it is intended that no more phosphoric acid will be applied for two or three years. Forty lbs. phosphoric acid may be supplied as the following forms :—

200 lbs. superphosphate, present cost ... Rs. 8- 0
250 ,, basic slag ,, ,, ... ,, 7-14

Of the two basic slag is generally much better for green crops.

Where heavy dressings are given one of the ground mineral phosphates may be used, both economically and efficiently.

200 lbs. Belgian Flour Phosphate, present cost ... Rs. 4-10
120 ,, Jardine's Ground Indian Phosphate ,, ,, ... ,, 4- 0
160 ,, Radiophos ,, ,, ... ,, 6- 7

and where nitrogen is necessary, also :—

100 lbs. nitrate of soda, present cost ... Rs. 9- 2
75 ,, sulphate of ammonia, present cost ... ,, 6- 6

or a light sprinkling of cattle manure, say 2 to 3 tons per acre. All manures for the green crop should be spread along the strip intended to be prepared as a seed bed for the green crop.

4. If jungle is growing, put in a hoe between the tea and the line of green crop, before the green crop is too big. A green crop may do more harm than good, if owing to its presence the garden is allowed to get dirty with bad jungle.

5. Get rid of the green crop after six, or at most, eight weeks' growth. If it has not grown sufficiently by then, it is usually because the weather is unfavourably dry, in which case the presence of the green crop is only a danger. Only if the poor

growth be due to cold and wet will the green crop do no harm and may be left.

The green crop is most efficient as manure if buried lightly with a hoe. If labour is too short to deal thus with the whole crop, the green stuff is still very valuable if cut, or slashed down with a hoe, and left to lie on the surface till the next light hoe comes along.

It may be observed that the losses of tea crop referred to are losses from tea growing among green crops compared to tea growing in clean soil. There would be little or no loss from the presence of a green crop if it took the place of much jungle. Even a heavy arhar crop would do less damage than a thick crop of thatch grass. A heavy green crop does a great deal to smother jungle, and in thatch-ridden places when it is known that cultivation will have to be deficient, a green crop, either quick-growing or semi-permanent, may be allowed to grow bigger than on soils which will be kept clean.

THE GOLAGHAT DISTRICT.

BY

C. R. HARLER.

SOIL SURVEY.

The Golaghat district includes all the Sibsagar gardens west of the Kakadanga River and comprises the sub-districts of Goriajan, Kakadanga, Golaghat and Dhansiri. The area under tea aggregates about 24,000 acres. The Dhansiri sub-district consisting in a few gardens situated between the Mikir Hills and the Brahmaputra has been described in a previous paper (Quarterly Journal, Pt. III, 1924.).

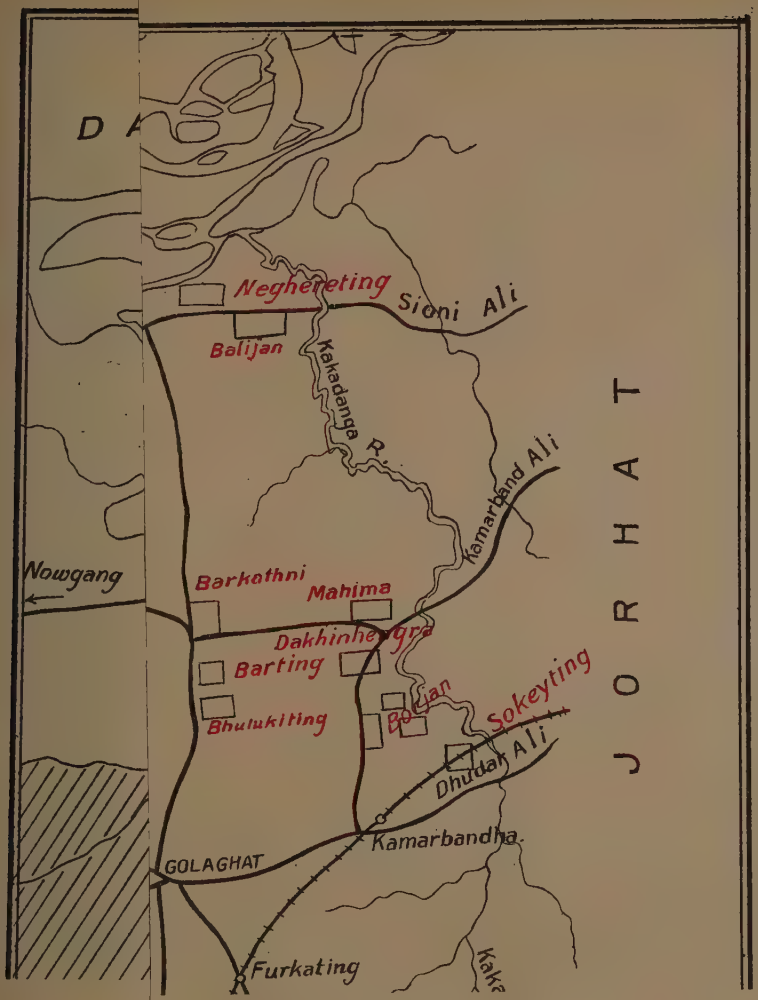
Geography and Geology.

The Mikir Hills form a convenient starting point for studying the geography and geology of the district. The core of the Mikirs is the ancient gneiss of peninsular India and the Shillong Plateau. The Mikir country is made up of jungle clad, undulating hills and to the south they rarely attain 1,500 feet. Round the foot of the North Mikir Hills which rise to over 4,000 feet, sedimentary rocks overlie the gneiss and stretch over the South Mikirs to the North Cachar Hills.* These younger rocks were evidently deposited on the ancient surface of the gneiss. The gardens which are put out on the south-eastern slopes of the hills are thus planted on soils formed from rocks similar to those which run round the whole of the Assam Valley.

The Dhansiri river wanders through the district and marks off roughly the well settled area from the sparsely settled part still largely under jungle. Along the banks of this river are patches of rich, black, new alluvium which grow vegetables and oats well but would probably be too alkaline for tea.

Most of the Golaghat gardens are put out on banks of red and yellow soil which crop out from the newer alluvium all over

*The Geology of the Mikir Hills of Assam, F. H. Smith, Mem. Geol. Sur. India, Vol. XXCII, part I.


Neghereting
Sioni Ali
Balijan
Kakadanga R.
Kamarband Ali
JORHAT
Nowgang
Barkathni
Mahima
Dakhinheygra
Barting
Bhulukiting
Boljan
Sokeyting
Dhudar Ali
Kamarbandha
GOLAGHAT
Furkating

the district. The whole of the floor of the Assam Valley may at one time have been composed of soil of the same age as these banks, but successive denudations and changes in the height of the valley have mixed the older soil with a much newer alluvium.

Climate.

Much of the Golaghat district lies in the leeway of the Mikir Hills which partly deflect the Monsoon current and partly take the rain before the clouds reach the tea areas. In the Dhansiri district situated in the main track of the Monsoon, the rainfall is satisfactory and this also applies to the Golaghat gardens put out near the Brahmaputra. The gardens to the immediate east of the Mikirs record decreasing rainfall as the distance from the Brahmaputra increases and some of the gardens depend primarily on the rainfall which comes up the Jetinga Valley from Sylhet.

The table below shows the monthly average rainfall on certain gardens over the last ten years.

	Jan.	Feb.	Mar.	Apl.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Jamguri	0·82	1·27	2·45	6·73	6·79	10·64	11·55	12·04	10·04	2·86	1·09	0·24	66·58
Negreting	0·62	1·88	3·55	7·82	10·50	11·86	14·60	14·05	10·16	3·77	0·79	0·46	79·78
Moheema	0·73	1·74	3·50	7·44	8·11	11·12	14·47	12·64	10·25	3·44	0·63	0·49	74·06

Golaghat is a sun-baked, thatch-ridden district and on the older gardens put out in the area east of the Dhansiri, clear of jungle and hence subject to drying breezes in the early part of the year, planting of shade is essential. The function of the shade, in addition to any crop increase it may give in inducing more leaf growth, is not only to act as a wind belt but also to keep down jungle.

Cold weather mists are rare in Golaghat or when they form are not so persistent as in Jorhat. One result of the dryness of the district is that when old wood is cut it does not grow again so readily as further up the valley where the drought is less severe and the cold weather atmosphere more humid. Another reason why old wood does not throw from near the cut is that bushes which are heavy pruned are generally those

which have failed to maintain a good crop and are cut down because they are weak. Quite apart from the climatic factor, heavy pruning is only really successful on healthy tea.

Another result of the dry climate in Golaghat is that the hard plucking employed in other parts of Assam is often too severe unless the bush is in good fettle.

The season starts late in Golaghat and the crop is accordingly a short one, the average yield being about seven maunds per acre. For some reason Golaghat is a quality district and, proceeding up the Assam Valley, it is the first stand out district for good teas. This is probably largely due to the heavy red soils although some of the Golaghat gardens on sandy soils also make fine teas. The dry atmosphere of the district also makes for a good wither and in this manner helps to produce good quality teas.

Soil Types.

Before describing in detail various garden types the function of the five soil fractions, coarse and fine sand, silt, fine silt and clay, may be briefly described. Course sand keeps a soil open and, up to a content of about 20 per cent., may be looked upon as an advantage. When it rises much above this value it may be a menace in that the moisture holding capacity of the soil is so reduced that it is liable to dry out in a drought. In the Bishnath district where the soil is very sandy, successive bad droughts are sufficient to kill young tea although when it is once established and has its roots well down into the soil, tea does remarkably well there.

Fine sand has the disadvantage that the surface soil containing a large percentage of this fraction is liable to crust on the top thus reducing aeration. If this crust is kept broken, then fine sand has most of the advantages of coarse sand without its draw-backs.

So far as has been observed all the tea soils having silt as a major fraction support good tea. On the other hand fine silt is a fraction which if present in large proportion renders the soil hard in the cold weather and cheesy in the rains.

Clay is an essential constituent of every soil and should be present in amount not less than 5 per cent. Clay is a colloid and has sticky properties so that if it is present in too great a proportion the soil becomes intractable, but if in too small proportion there is insufficient binding material in the soil.

The hot, baking sun of India robs clay of most of its terrors for during the cold weather the soil dries and takes on good tilth again with the rains. The drying of a clay soil is essential if good tilth is to be maintained, hence the advantage of a deep hoe which breaks the connection between the top soil and the sub-soil and ensures a certain degree of drying.

An ideal soil for tea contains as major fractions silt and coarse sand with a fair percentage of clay. Soils of the type 3, 1, 5 and 1, 3, 5 always carry good tea, so far as our experience goes.

The Doom Dooma soils, which carry the best tea in Assam, are not of the types mentioned, but much more sandy. The goodness of the tea here is due primarily to the climate and depth of soil rather than to the type of soil. Sands are good for tea provided that the climate is favourable.

The silty type of soil and its variations occur in the Dina-Toorsa district of the Dooars and on parts of the Red Bank. The table below illustrates both the soil approximating to the ideal and the method of soil nomenclature.

Fraction.	Fraction number.	Dina-Toorsa.	Nagrakata.
Coarse sand	1	32%	16%
Fine sand	2	13%	4%
Silt	3	24%	52%
Fine silt	4	8%	3%
Clay	5	19%	24%
	Type ...	1,3,5,2,4	3,1,5,2,4

Golaghat soils.

The Golaghat soils vary over a wide range although there are distinguishable two main groups, one resembling the Jorhat sands as met at Tocklai and Borbhetta and the other a stiffer soil with fine silt and clay as major

fractions. The clay type is a red soil and the other type greyish. A third distinctive type occurs at Ghilladhari, Hautley, Rangagora and Negreting, showing high fine sand and fine silt as major fractions. This type of soils happens to be stiff and yellow.

Individual Golaghat soils are now described starting at Letekujan and working through the area west of the Dhansiri to Nambar Naddi. The gardens between the railway and the Naga Hills follow and then those in the centre of the district and near the Brahmaputra. All the values given in the tables refer to percentages.

Letekujan is planted on a red outcrop situated similarly to the Numaligarh bank. Two analyses are available and show the following :—

	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Letekujan—Dhekijan typical	7	40	24	15	10	3·27	2, 3, 4, 5, 1
,, —Hathimara ...	2	35	32	20	8	2·60	2, 3, 4, 5, 1

The Dhekiajan sample is the better soil for it has a slight advantage from the physical point of view and a considerable advantage in the loss on ignition which is, to a certain extent, a measure of the organic matter in a soil. Soils similar to these are very common both in the Jorhat and Sibsagar districts.

Marangi is a new garden very near to Letekujan standing on a bluff round which the Dhansiri sweeps. The situation is exposed and shading should do much good here. Most of the land is jungle land but a certain part is burnt thatch land and here the soil is black as is common in such areas. The analyses show :—

Soil.	Coarse sand.	Fine sand.	Silt.	Fine Silt.	Clay.	Loss on ign.	Type.
Marangi No. 2 ...	8	37	19	17	14	4·83	2, 3, 4, 5, 1
,, ,, 4 ...	5	15	23	28	23	5·74	4, 3, 5, 2, 1
,, ,, 8 ...	1	22	32	28	13	3.42	3, 4, 2, 5, 1

No. 2 is the sandy type while No. 4 is the heavier clay type. No. 8 is a whitish soil rather poor in organic matter.

No analyses of Dolaguri nor Katoni are available. The soils here appear to be of the sandy rather than the heavy type.

At Garanga the following analyses are obtained :—

Soil.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Garanga No. 8 ...	1	18	28	30	18	4·76	4, 3, 2, 5, 1
„ „ 8A ...	1	15	26	33	20	4·96	4, 3, 5, 2, 1

Both soils are decidedly on the stiff side.

At Bukhial two types occur, one a stiffish clay and the other a sandy soil with a good clay percentage, this second example being a very good soil.

Soil.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Bukhial	8	18	22	25	16	4·71	4, 3, 2, 5, 1
„	11	28	25	8	20	5·12	2, 3, 5, 1, 4

Murphulani is a new garden in the jungle to the north of a spur of the Mikir Hills. Most of the jungle is secondary following *jhooming* of many years ago. Simul and amluckie are common trees about here and Murphulani is put out in an area where nahor abounds. This tree may be taken as a good sign just as ajar may be taken as the opposite so far as tea is concerned on account of its preference for swampy places.

Three analyses are available, two of which show the characteristic, rare for Golaghat, of coarse sand as a major showing fraction. Nambar Naddi and Rangajan are the only other gardens showing soils of this type. The third analysis shows the common sandy type of soil.

Soil.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Murphulani 6D, Jungle ...	30	29	11	14	11	3·88	1, 2, 4, 3, 5
„ 2A, „ ...	44	25	8	11	8	4·11	1, 2, 4, 5, 3
„ west boundary ...	8	45	12	15	16	4·61	2, 4, 5, 3, 1

All three samples are taken from the jungle just away from the tea in the direction of extensions. The tea already growing on similar soils is very fine.

Rangajan although an old garden has a large area of new tea put on virgin soil. Two soil types occur here, the clay and an uncommon type containing much coarse sand.

Soil.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Rangajan No. 10B ...	23	21	20	18	13	3·82	1, 2, 3, 4, 5
,, ,, 12 ...	2	20	26	30	18	3·53	4, 3, 2, 5, 1

No. 10B is an evenly graded soil. No. 12, described as typical, is a stiff clay, difficult to work.

At Thorajan the soils are considerably lighter than at Rangajan, as the analyses show.

Soil.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Thorajan No. 5B ...	1	44	24	17	11	3·28	2, 3, 4, 5, 1
,, No. 9 ...	1	20	35	26	12	3·91	3, 4, 2, 5, 1
,, No. 2 ...	2	23	24	30	13	3 68	4, 3, 2, 5, 1

Nambar Naddi is reached by a road running for about 15 miles through the jungle from Thorajan. At Garam Pani in the Nambar Reserve are hot springs one of which discharges into a small tank which steams and bubbles and presents a curious sight. The temperature of this tank taken in January, was 105°F. Just past Singlijan, an Indian owned garden, the road dips and suddenly enters the Barpathar, a great stretch of rice land lying in a cup and surrounded by jungle. All along the road occur quartz stones of a similar nature to those found in the Koliani River near Murphulani.

The garden of Nambar Naddi is put out on a red bank, south of the spur on the north side of which is Murphulani.

During the monsoon rain is plentiful but in the early months of the year this Mikir spur is a serious obstacle to precipitation. The clouds roll up to the northern slope of the spur and top the graceful line of hills only to divide and miss the garden. However if there is sufficient rainfall to support the magnificient jungle round about there should be sufficient to keep the tea bush. Shade, green cropping, mulching and the application of potash manure to delay the flushing, will all help to minimise the effects of the drought.

Of the Nambar Naddi soil analyses to hand, one shows the rare coarse sandy type, and the others variations of the common sandy type.

Soil.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Nambar Naddi No. 13 ...	30	25	16	11	12	4·0	1, 2, 3, 5, 4
,, ,, No. 4 ...	17	25	25	16	13	3·76	3, 2, 1, 4, 5
,, ,, No. 1 ...	18	41	9	11	13	5·75	2 1, 5, 4, 3

Both Nos. 13 and 1 are typical of certain areas of the garden and are of great theoretical interest in that they are of the type common to most of the sandy *teelas* of South Sylhet, belonging to the Tipam Sandstones. Sample No. 4 appears to be a water sorted soil.

It is probable that much of the area under jungle to the west of the Dhansiri is good for tea although the bigger banks are difficult to find and korkani is common. Most of the area is badly cut up by hullahs. In putting out new tea lands however the first point to consider is rainfall distribution.

To the east of the Dhansiri outcrops of older, red soils occur very frequently and a tea garden usually denotes high red land. It often occurs however that these banks are light sands.

Doyang, Jamguri and Wokha, gardens close together, show wide variations in soil types.

Doyang is composed wholly of the sandy type.

Soil.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Doyang No. 3 ...	1	28	28	22	16	3·92	3, 2, 4, 5, 1
,, No. 14 ...	4	45	21	18	9	2·70	2, 3, 4, 5, 1
,, No. 36 ...	5	33	31	19	10	2·85	2, 3, 4, 5, 1

Jamguri shows the type in which silt predominates. A larger percentage of coarse sand would make this soil one of ideal texture.

Soil.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Jamguri No. 1 ...	3	25	44	7	14	3·54	3, 2, 5, 4, 1
,, No. 7 ...	3	29	42	8	11	3·15	3, 2, 5, 4, 1
,, No. 4 ...	4	25	45	7	13	3·52	3, 2, 5, 4, 1

At Wokha the Jamguri type exists and also variations which show an increase in the clay fraction and a large increase in the fine silt which makes the soil hard.

Soil.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Wokha G. 8 ...	5	18	41	15	14	3·65	3, 2, 4, 5, 2
,, G. 10 ...	3	22	39	17	13	3·11	3, 2, 4, 5, 1
,, No. 1 ...	1	16	31	21	25	3·83	3, 5, 4, 2, 1
,, No. 2 ...	2	16	33	22	20	3·99	3, 4, 5, 2, 1
,, No. 3 ...	nil	11	28	23	30	3·95	5, 3, 4, 2, 1
,, No. 4 ...	2	10	22	26	32	4·25	5, 4, 3, 2, 1

At Ghilladhary the soil is an unkind, yellow clay of the 4, 2 and 2, 4 types, both these fractions, fine sand and fine silt tending towards hard packing.

Soil.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Ghilladhari, N. ...	9	22	13	30	20	3·94	4, 2, 5, 3, 1
,, O. ...	2	31	18	27	16	2·84	2, 4, 3, 5, 1

No analyses are available of Makrang.

Of Borjan and its outgardens Chotajan and Botubari many analyses are available but of the type showing the fine silt and clay as one fraction. At Borjan the combined fine silt and clay fraction is not a major one and the soils are of the light sandy type found in Jorhat. At Botubari the soil is generally heavier and at Chotajan much heavier than at Borjan.

Soil.		Coarse sand.	Fine sand.	Silt.	Fine silt and clay.	Loss on ign.	Type.
Borjan	A.	12	38	35	11	4·42	2, 3, 1, 4
,,	B.	8	43	32	12	4·50	2, 3, 4, 1
,,	C.	5	43	38	9	4·00	2, 3, 4, 1
,,	D.	3	28	43	20	4·94	3, 2, 4, 1
,,	E.	3	42	30	20	4·20	2, 3, 4, 1
,,	F.	4	48	37	16	4·12	2, 3, 4, 1
Botubari	G.	2	24	36	33	5·35	3, 4, 2, 1
,,	H.	5	34	41	16	5·50	3, 2, 4, 1
Chotajan	I	31	23	32	37	4·95	4, 3, 2, 1
,,	J.	3	22	34	36	5·30	4, 3, 2, 1
,,	K.	2	21	36	36	4·57	4, 3, 2, 1

At Moheema both sandy and clay types occur and from this garden the analyses of the sub-soil are also available, showing a close resemblance in every way, both physical and chemical, with the top soil.

Soil.		Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Moheema	A Top ...	10	29	21	17	18	2·75	2, 3, 4, 5, 1
	Sub ...	6	26	22	22	19	3·43	2, 3, 4, 5, 1
,,	B Top ...	4	21	29	25	15	3·80	3, 4, 2, 5, 1
	Sub ...	4	14	30	29	21	3·71	3, 4, 5, 2, 1
,,	C Top ...	1	14	17	27	32	6·31	5, 4, 3, 2, 1
	Sub ...	*nil*	12	16	25	39	6·35	5, 4, 3, 2, 1
,,	D Top ...	4	28	79	19	14	3·58	3, 2, 4, 5, 1
	Sub ...	*nil*	19	36	25	23	3·90	3, 4, 5, 2, 1
,,	E Top ...	*nil*	40	24	19	10	2·98	2, 3, 4, 5, 1
	Sub ...	*nil*	36	25	20	14	2·27	2, 3, 4, 5, 1

None of these soils are light or easy to work and sample *C* is apparently one of the heaviest in the district. The stickiness of such clays actually depends on the colloidal clay content,

a figure which our analyses do not give. Thus a soil may possess a large clay fraction yet most of the clay particles may be only slightly smaller than fine silt and hence not liable to possess highly developed colloidal properties. It often happens that lateritic soils showing high clay percentages are not sticky.

At Borkatoni and Bulakating both sands and clays occur. The examples given are typical of certain areas of the gardens.

Soil.	Coarse sand	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Borkatoni No. 5 ...	1	15	27	31	19	5·17	4, 3, 5, 2, 1
„ „ 7 ...	*nil*	21	34	25	15	3·69	3, 4, 2, 5, 1
Bulakating No. 8 ...	1	14	18	38	22	5·69	4, 5, 3, 2, 1
„ „ 6 ...	1	35	24	20	14	4·46	2, 3, 4, 5, 1

From Halmira and North Garanga no analyses are available.

In Hautley the sandy type and the yellow clay of the 4, 2 type met at Ghilladhary and Negreting are found.

Soil.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type
Hautley A H 6 ...	3	32	22	17	18	3·88	2, 3, 4, 5, 1
„ A H 7 ...	8	31	21	19	14	3 90	2, 3. 4, 5, 1
„ A H 8 ...	1	36	9	33	13	5·52	2, 4, 5, 3, 1

The third example is slightly alkaline although it grows tea successfully. This soil is an instance where lime even in small doses would do harm and the addition of acid manures is to be recommended.

The Koomtai soils are generally light clays although No. 11 is a much more open type on account of the high content of coarse sand.

Soil.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Koomtai No. 4 ...	6	22	26	23	15	3·52	3, 4, 2, 5, 1
„ No. 10 ...	2	23	25	17	16	3·47	2, 3, 4, 5, 1
„ No. 11 ...	19	28	18	16	14	2·12	2, 1, 3, 4, 5
Hindriting No. 1 ...	1	30	23	19	21	3·55	2, 3, 5, 4, 1
„ No. 2 ...	1	40	22	15	16	3·78	2, 3, 5, 4, 1

From Badulipar and Goriajan come a similar set of soils evenly graded and generally possessing too small a percentage of coarse sand to be much service in keeping the soil friable. Badulipar Nos. 3 and 4 are stiff clays needing constant green cropping if they are to be kept friable.

Soil.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Badulipar No. 1 ...	9	34	20	16	15	2·93	2, 3, 4, 5, 1
,, No. 2 ...	2	36	24	17	14	3·45	2, 3, 4, 5, 1
,, No. 3 ...	6	25	19	19	24	4·12	2, 5, 3, 4, 1
,, No. 4 ...	5	26	19	19	24	4·43	2, 5, 3, 4, 1
Goriajan No. 3 ...	8	27	28	16	15	3·84	3, 2, 4, 5, 1
,, No. 6 ...	7	28	27	18	14	3·11	3, 4, 2, 5, 1

From Dooria both types, the sandy and the clay, are obtained.

Soil.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Dooria No. 88 ...	2	18	26	28	21	6·10	4, 3, 5, 2, 1
,, No. 97 ...	1	35	28	20	10	3·56	2, 3, 4, 5, 1
,, No. 97 sub-soil	3	16	18	28	28	6·61	5, 4, 3, 2, 1
Barfolong No. 11 ...	5	28	25	19	17	5·19	2, 3, 4, 5, 1

No. 88 is described as the best soil and No. 97 as the worst soil in the garden. It will be observed that the sub-soil of No. 97 is extremely heavy and this to a certain extent may account for the poorness of the section. The Barfolong soil is typical of this division.

At Rangagora the normal sandy type occurs.

Soil.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Rangagora No. 1 ...	9	41	17	14	10	3·58	2, 3, 4, 5, 1
,, No. 2 ...	19	39	17	12	5	2·97	2, 1, 3, 4, 5
,, No. 3 ...	1	30	29	18	11	4·32	2, 3, 4, 5, 1

No. 2 is very light for the Golaghat district.

Later analyses of the garden show the following :—

Soil.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Rangagora Borkal ...	3	32	32	16	14	3 93	3, 2, 4, 5, 1
,, Kolpuli ...	3	30	30	15	18	4 26	2, 3, 5, 4, 1
,, Bungalow ...	7	39	27	15	11	2·97	2, 3, 4, 5, 1
,, ...	17	42	18	10	10	2·52	2, 3, 1, 5, 4

These soils are evenly graded and difficult to work and constant green cropping is essential.

From Rangamatty the soil analyses show fine silt and clay as one fraction. The soils resemble the heavier ones of Rangagora.

Soil.	Coarse sand.	Fine sand.	Silt.	Fine silt and clay.	Loss on ign.	Type.
Rangamutty No. 5 ...	5	25	30	34	6·11	4, 3, 2, 1
,, No. 11 ...	2	48	28	18	4·05	2, 3, 4, 1
,, No. 17 ...	3	41	25	24	5·41	2, 3, 4, 1
,, No. 22 ...	5	33	29	28	5·36	2, 4, 3, 1
Khematty R. ...	1	27	28	28	5·36	2, 4, 3, 1

At Negreting all the analyses show soils of the 2, 4 or 4, 2 type.

Soil.	Coarse sand.	Fine sand.	Silt.	Fine silt.	Clay.	Loss on ign.	Type.
Negreting Sec. 9 ...	13	33	20	25	3	3·97	2, 4, 3, 1, 5
,, ,, 15 ...	17	21	17	27	12	4·29	4, 2, 1, 3, 5
,, ,, 24 ...	10	27	22	27	10	4·34	2, 4, 3, 1, 5
,, ,, 32 ...	12	33	19	26	6	3·62	2, 4, 3, 1, 5

The treatment of Golaghat soils.

The red soils of Golaghat, although they are easy and friable when first turned as virgin soil, become intractable unless they are liberally green cropped and carecully cultivated. Although some of these soils are inclined to be heavy and retain moisture well in the cold

weather there is often a tendency to suffer from drought owing to a shallow rooting system. On one or two gardens it has been observed that deep drainage not only takes the roots down but, it is claimed, improves the tilth of the sub-soil.

It is often observed that where the slope of the bank is not very steep, the bushes at the bottom end of the slope are weak. Such areas are in need of protection drains and a drain cut across the slope, contoured and leading into a sub-main drain down the slope greatly improves these low lying areas.

On some of the stickier soils of Golaghat an application of 10 maunds slaked lime per acre would do much to improve the tilth. This is added purely with regard to the physical state of soil and not as a plant food nor with the object of reducing the soil acidity.

Chemically the Golaghat soils are poor with a serious shortage in organic matter and nitrogen. With the heavier type of soil a loss on ignition of 6 per cent. should be looked for and on the lighter type at least 3.5 per cent. These values must be accepted with caution for the loss on ignition not only represents organic matter but water of crystallisation. It is also possible to have a soil with a loss on ignition of 30 per cent. or so, such as is met in deteriorated *bheels,* with bushes which are suffering from lack of organic matter since that present is in a non-available form. Such soils respond readily to green cropping. The nitrogen content of the Golaghat soils should be at least 0.15 per cent. on the clays and 0.10 per cent. on the sands.

It has been noticed that potash manures sometimes depress the crop slightly on clay soils and in arranging a manuring programme this constituent should be added to most of the Golaghat soils (except the sandy ones) with the object of strengthening the bush to ward off fungus attack rather than with the object of producing more leaf. Phosphatic manures in conjunction with nitrogen do well on clay soils.

The following may be taken as a guide for a suitable five-year manuring cycle with the approximate cost, exclusive of labour and freight.

		Approx. cost.
1.	Cowpeas or dhaincha	Rs. 4
	with 2 cwt. Belgian flour phosphate per acre	,, 6
	or	
	5 tons cattle manure per acre	
2.	Sulphate of ammonia 150 lbs. per acre	,, 14
	Muriate of potash 40 ,, ,, ,, ,,	,, 3
	Broadcast with early rains.	
3.	Boga medeloa in alternate rows ...	,, 5
	lopped at intervals, with 2 cwt. Belgian flour phosphate per acre	,, 6
4.	Trench in Boga medeloa	
5.	Sulphate of ammonia ... 150 lbs.	,, 14
	Muriate of potash ... 40 ,, ,,	,, 3
	Superphosphate ... ... 100 ,, ,,	,, 6
	Broadcast with early rains.	
		Total Rs. 61

Thus the actual cost per acre over the whole garden is about Rs. 12.

On the sandier soils, the Belgian flour phosphate may be omitted in the third year and in the second and fifth years the following mixture may be substituted for that suggested with clays :—

Sulphate of ammonia 150 lbs.
Muriate of potash 60 lbs.

Practically none of the Golaghat soils are so light that there need be fear in a normal year of any serious loss of chemical manures through leaching.

A fair estimate nowadays for manuring is Rs. 25 per acre and it is economically sound to add in addition to the cycle given, mixture 2 in the third year and mixture 5 in the fourth year which brings the total cost up to about Rs. 20 per acre, exclusive of labour and freight.

CROP CONTROL.

BY

P. H. CARPENTER.

With the policy of crop control the Scientific Department has no concern, but in the event of such a policy being adopted, it is the duty of the Scientific Department to indicate the means that should be employed to bring this about and at the same time ensure the greatest benefit to the tea bushes. It is more particularly with the bushes, and the maintenance of them in a condition to meet the varying requirements of the industry in the best manner that this Department is concerned.

The method adopted for producing crop restriction should be such that at a subsequent time when an increased crop is required the bushes shall be in a condition to yield such increased crop. Any method therefore that may be described as starvation must be rejected, since whilst this will result in reduction of the crop and a saving in expense, yet it will bring the bushes into such a condition that they will be unable to respond with an increased crop when that is demanded.

A consideration of the bush itself may enable one to formulate a scheme that shall not only avoid weakening the bush but will actually strengthen it, and yet at the same time shall not result in additional expenditure and so increase to an undesirable extent the cost of the smaller crop harvested.

During the war and for several years afterwards a large crop of tea was gathered and this was obtained in many cases at the expense of the health of the bush with the result that the bushes became debilitated. This condition was the more noticeable because the use of manures had for various causes ceased or been very severely curtailed. It has taken some years of careful treatment to bring bushes back again into a condition of health that will permit them to give large crops. It would be a greatly mistaken policy that would allow bushes to revert again to a weakly condition.

There are however large areas of tea that are still in poor condition and any scheme for crop control should be such as will encourage these poorer areas of tea to improve. . One of the first necessities for a poor bush to improve its condition is to relieve it of work as much as possible and to allow it to grow in a natural and normal manner with the least disturbance. This may well be described as resting a bush. The work of a bush is to produce leaf for plucking and to rest a bush is to relieve it of this work, that is to say to leave it unplucked, and it is the opinion of the writer that no better treatment for improving a bush can be given than to give it a complete rest from plucking for at least one full season. Sir J. C. Bose has stated that plants possess a nervous system and that implies that plants can be subjected to shock. Damage to growing tissue such as plucking a shoot produces shock and to a weakly bush the accumulative shock effect of plucking a number of shoots periodically from it may well be sufficient to debilitate the bush still more. Leaving a bush unplucked will then relieve the bush of the shock produced by plucking. Also a shoot is fed by the leaves growing on it, hence an unplucked shoot will grow strongly.

The suggestion is that on those gardens where crop restriction is desired this should be brought about by allowing the poorer areas of tea to be unplucked for a season. Such resting of areas must not for a moment be considered as partial abandonment for whilst the area is unplucked yet that does not mean that that area is to be neglected. On the contrary cultivation must be maintained. The area must be kept clean. It will be found that the area, owing to the bushes growing high in the course of the year will be more easily kept clean than it would have been had the bushes been kept to a plucking height, and it will be unnecessary to do as many rounds of light hoeing during the year as in the same area when plucked. This is not a point that should be stressed for the first consideration is to do all that can be done to improve the health of the tea bushes and to obtain the best result in this direction it is essential that the jungle shall not be allowed to grow. Generally if the first, second or third rounds of cultivation are put in when labour is

available, the tea will provide sufficient cover to keep down jungle for the rest of the season. At the end of the year bushes so treated should be pruned to two or three fingers of new wood in the same manner as if they had been plucked. This pruning is necessary even if the area is to be left unplucked a second year, otherwise the bush may flower and be thus greatly reduced in vitality. It will be found that weakly bushes so treated have very markedly improved in their general condition, but in the case of some very debilitated areas it may be found necessary to allow them to remain unplucked for even a second year. This provides a simple and effective means of restricting crop and at the same time of improving the general health and condition of the poorer bushes and of bringing them into a condition so that when larger crops are required they shall be in a condition to yield such larger crops. There is also another important consideration that needs to be noticed, and that is that the only labour that is required on such areas is that for cultivation. This means that more labour is available for plucking the other and better areas of the garden. In these days when labour is scarce this is important, for it allows of those areas that are to be plucked, being plucked properly and at regular intervals. This will result in better leaf being plucked and consequently in better tea being made. Only the good healthy areas which will not be damaged by plucking will be plucked, and it will be possible to pluck these areas to their full extent. Such healthy areas will not suffer and the plucking of areas that would be further weakened by plucking has been avoided. It would be a mistake to allow a good healthy area to be unplucked ; only the weakest areas in the garden should be selected for this treatment.

It is not of course always necessary to leave an area unplucked for the whole of a season. It can be plucked at the commencement ; and then, later on, so soon as the difficulty of plucking at regular intervals becomes noticeable, the poorer areas can be left unplucked for the remainder of the season, or until the pressure of plucking rapid growth is again relaxed towards the end of the season. It must not however be expected that

leaving a bush unplucked for part of a season will result in the same amount of good to the bush as would be obtained by leaving a bush unplucked for the whole season.

This system of crop control has been dealt with at some length as it appears to be the one that will give the most satisfactory and beneficial results.

A useful modification of the system is to leave on a garden large areas of unpruned tea, if possible half the plucking area. The unpruned area is plucked during the early part of the season, say until the end of June and then it is allowed to go unplucked for the remainder of the season. The pruned area is left unplucked at the beginning of the season until say the end of June. Then when the unpruned area is thrown out of plucking the pruned area is taken into plucking.

There are however other methods that need to be considered.

It may be that an area of tea cannot be considered as being sufficiently weakly to justify it being left unplucked for a season or even part of a season, and yet it may be in such a condition that it is not at its best. It may be, for instance, growing spindly wood. Such areas lend themselves to another system that is not so drastic as that suggested above. To increase the thickness of a piece of wood the length of the new wood must be increased. That is to say, if the bush is producing thin twiggy wood, then in order to make it produce thicker new wood the length of growth of the shoot must be increased. This can be done by allowing a greater length of growth at the beginning of the season before tipping, or it can be done by plucking for a longer period of time over one or two fully developed leaves before coming down to the jhanum or fish leaf. Either of these two methods can be adopted for the production of thicker new wood but one point needs to be carefully considered. The plucking for a longer period of time over fully developed leaves will result in the plucking surface of the bush tending towards an umbrella shape. That is to say, the centre of the bush will develop to a greater extent than the sides,

with the result that a greater thickness of wood will be developed in the stronger shoots in the centre of the bush than in the more weakly side shoots. This is not the most desirable result. It would be better to obtain a development of the side shoots more nearly equal in thickness to those in the centre. This can be accomplished if the centre of the bush is kept down and the conical shape avoided. This result is more easily accomplished by allowing a longer length of growth at the beginning of the season, than by the system of leaving leaves. The bush can then be plucked close in the centre whilst allowing the sides to come up to the increased plucking height before plucking. This results in a flatter topped bush and prevents the centres from running away. There is one other point that needs to be considered. It is of great importance that good tea shall be made and the quality of the tea made is largely dependent upon the plucking. Leaf plucked over a long length of green wood makes poorer tea than that plucked over a shorter length of green wood. The system of plucking for a long period of time over fully developed leaves, results in a long length of green wood and hence produces poorer quality tea. If however the long length of wood is left at the beginning of the season, and, immediately after that, the bush is plucked close, the green wood so left in the early part of the year will become red wood towards the end of the season and only a short length of green wood will be found. This system of plucking, whilst giving a long length of green wood in the early part of the season and consequently of poor quality leaf, results in a much improved quality of leaf towards the end of the season. In this case only part of the season gives poor quality of leaf whereas plucking over fully developed leaves for any considerable period results in poor quality of leaf being produced throughout the whole season.

It is natural that at such times as a smaller tea crop is required, that attention should be turned towards heavy pruning and this may well be done to bushes that have diseased, insect bored or white ant eaten wood, but it must be remembered that heavy pruning alone is not a method for renovating poor

bushes. The shock of such drastic treatment may well result in still further weakening the bushes unless it is accompanied by liberal treatment both in regard to manuring and plucking. If crop restriction is to be brought about by heavy pruning it must not be accompanied by a restriction of expenditure on manures. The manuring of areas that are to be unplucked need not be on so liberal a scale as for bushes that are being plucked, and also it may be possible to curtail to some extent the quantity of nitrogenous manure employed, but this is not recommended, and to use those manures which rather tend towards a permanent improvement of the bushes than in an immediate leaf production. The restriction of the use of nitrogen should be used cautiously and no such reduction should be allowed on really poor areas. A plant needs leaves to obtain from the air the most important part of its plant food and also to elaborate both this and the other crude food materials supplied by its roots. Therefore the larger the amount of healthy leaf there is on the bush the better it is being fed. Nitrogenous manures stimulate leaf production and are therefore useful for renovating poor tea even if it is to be left unplucked. The larger amount of leaf produced on such bushes will stimulate the formation of a larger number of roots.

Heavy pruning makes a great demand on labour. The heavy pruned bush provides no cover, and needs much more cultivation than a high bush. This cultivation however is most essential in the early part of the season when labour is still available. Cultivation may well be dropped when a strong bush has developed in the latter half of the season. The yield from heavy pruned tea is in any case inconsiderable ; and it is recommended that heavy pruned tea be left unplucked not only to strengthen it, but to hasten the time when cultivation may be dropped. Manuring also helps in this direction.

NOTES.

MYCORHIZA ON TEA PLANTS.

BY

A. C. TUNSTALL.

It has long been known that fungi are habitually associated with the roots of many plants. These fungi have in a number of cases been proved to be beneficial to the host plant. The root in combination with its fungus is called a Mycorhiza. Of recent years considerable attention has been paid to the role of these fungi and it is interesting to note that similar fungi are present on tea roots. The roots of the tea bushes growing at Tocklai were found on examination to be infected. The infection was not confined to any particular blocks. It was found that the use of heavy dressings of lime caused no apparent diminution in the degree of infection.

The Mycorhiza fungi penetrate the outer cells of the roots producing knots of fungal threads within the cells. These filaments are continuous with those outside the root. It is possible that under favourable conditions the external fungus filaments function as additional root hairs thus increasing the absorbing area of the roots.

The utilisation of the products absorbed by the fungus from the soil water may be brought about by direct transference through the walls of the fungus filaments or by the death of portions of the fungus and subsequent digestion within the cells of the host plant.

The Mycorhiza fungus in the tea plant appears to thrive on the small white rootlets. It is also present in the cells of the younger of the conducting roots.

Further research may demonstrate the usefulness of the Mycorhiza on tea and it is possible that in certain situations, *e.g.*, on bheels, they may be of considerable importance.

PROPOSED TOURING PROGRAMME

OF

OFFICERS OF THE SCIENTIFIC DEPARTMENT DURING 1926.

	P. H. Carpenter.	H. R. Cooper.	C. R. Harler.	C. J. Harrison.	E. A. Andrews.	A. C. Tunstall.
January	Jalpaiguri	Bishnauth	Mal	Tocklai	Tocklai	Tocklai
February	Silchar & Calcutta	Tocklai	Doom Dooma & Margherita	do.		Dhunsiri & Nowgong
March	Tocklai	Lungla, Doloi & Juri	Terai	do.	H	Tocklai
April	do.	Tocklai	Dooars	Dooars	O M E	Chargola & Longai
May	Jhanzie	do.	do.	Tocklai		Tocklai
June	Calcutta & Dooars	do.	do.	do.		do.
July	Tocklai	Dibrugarh & Panitola	do.	do.	L E	Dooars
August	do.	Happy Valley & Lakhipur	do.	do.	A V	do.
September	Dooars & Darjeeling	Tocklai	Tocklai	Tingri	E	Tocklai
October	Tocklai	do.	do	Tocklai		do.
November	do.	do.	do.	do.	Tocklai	do.
December	do.	do.	do.	do.	do.	do.